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Emerging Trends in Nano Technology for Modern Industries

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Abstract*— Whenever we go for a morning walk in the Mughal Garden, we see peacocks dancing with their colourful feathers. When we look at the deep and beautiful colours on the feathers of the peacock, we have often wondered how even after many years, the colour of the peacock feather does not fade away. Even we keep peacock feathers in our books. This phenomenon of long lasting original colour to the peacock has come from God's own creation of Nano materials coated in a peacock's feather; and they diffract light, which gives us the rich colours Everything in this universe — from giant stars to our bodies work on a molecular scale. Our hearts and lungs are big objects but all the processes take place at the molecular level. Therefore, everything in our body and in the physical universe is already based on nanotechnology. Observation of nature and the role of science in understanding it from our research in nano sciences can be converted into a technological product by using the same or similar nano materials which gave the natural colour to the peacock's feathers, as part of our shirts, sarees, fabric and apparels. It is a welcome destination for science to mature into technology and become a product of utility for society. Nanotechnology has transformed and modernized the materials industry by empowering scientists to manipulate materials at the atomic level. Nanotechnology, is the ability to work with matter at a nanoscale, measured in the length of approximately one-to-100 nanometers (a nanometer being one billionth of a meter)-which changes the fundamental properties of matter. One nanometer being equivalent to the width of three or four atoms. "It is more restrictive than most definitions, but contains critical distinctions that help guide people to true applications of nanotechnology, such as the specification that there must be novel features due specifically to the smaller size." —Greg Schmergel In this paper we have discussed the use of Nanotechnology in various areas Industry. Today, RFID is used in enterprise supply chain management to improve the efficiency of inventory tracking and management. However, growth and adoption in the enterprise supply chain market is limited because current commercial technology does not link the indoor tracking to the overall end-to-end supply chain visibility. RFID (Radio Frequency Identification) is new emerging area, work on radio frequency & used for material tracking. The product identification & tracking is today's major demand in garment & RFID come with some latest features. RFID is with major features to help production calculation. There still are some drawbacks which make nanotechnology to enter in this new area Coupled with fair cost-sharing mechanisms, rational motives and justified returns from RFID technology investments are the key ingredients to achieve long-term and sustainable RFID technology adoption. Nano in this sector is growing and made presence effectively. We also discussed the application of nanotechnology in the field of barcodes & RFID. While nanotechnology applications in textile, chemical, mechanical materials are already taking the world by storm, it's something of a surprise that its potential application in machinery and processes has not yet been explored. In this paper we tried to cover the application of nanotechnology in the advancements made in material science and technology which gave the impetus for both the nuclear and biological age to flourish. Succession of these technology periods has involved progression from simpler materials to more complex forms of science and engineering. We are today at the convergence of nano, bio and information technologies. This age, we feel will create a historic revolution and we must be in the driver's seat to contribute towards this societal change.

Index Terms— **Evolution of Nanotechnology, Moores Laws, Molecular Nanotechnology, Nano Materials, Nano Composites, RFID.**

I. INTRODUCTION

'Nanotechnology' is the **engineering of functional systems at the molecular scale.** This covers current work and concepts that are more advanced. It is the design, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape at the nanometer scale (atomic, molecular, and macromolecular scale) that produces structures, devices, and systems with at least one novel/superior characteristic or property. In its original sense, nanotechnology refers to the projected ability to construct items from the bottom up, using techniques and tools being developed today to make complete, highly advanced products. The ability to see nano-sized materials has opened up a world of possibilities in a variety of industries and scientific endeavors. Because nanotechnology is essentially a set of techniques that allow manipulation of properties at a very small scale, it can have many applications. When it's unclear from the context whether we're using the specific definition of "nanotechnology" or the broader and more inclusive definition, we'll use the terms "molecular nanotechnology" or "molecular manufacturing." Molecular nanotechnology is an emerging, interdisciplinary field combining principles of molecular chemistry and physics with the engineering principles of mechanical design, structural analysis, computer science, electrical engineering, and systems engineering.

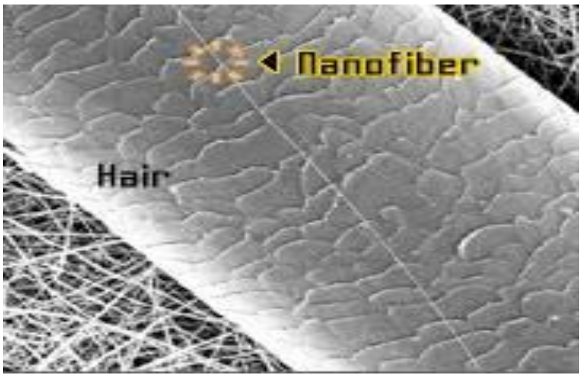

Fig 1 Nano Fibre Compared With Human Hair

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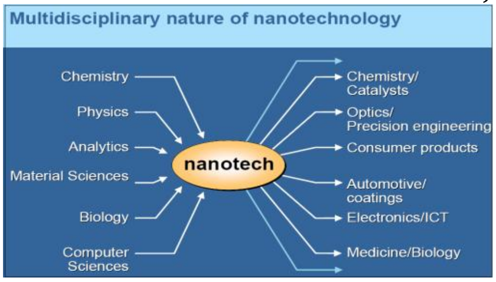

Fig 2 Multidisciplinary Nature of Nanotechnology

Molecular manufacturing is a method conceived for the processing and rearrangement of atoms to fabricate custom products.

- Get essentially every atom in the right place.
- Make almost any structure consistent with the laws of physics that we can specify in molecular detail.
- Have manufacturing costs not greatly exceeding the cost of the required raw materials and energy.

There are two more concepts commonly associated with nanotechnology:

✓ Positional assembly ✓ Massive parallelism

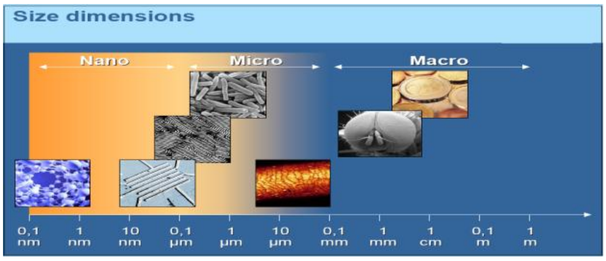

Fig 3 Different Size Dimensions of Nano Material

It's worth pointing out that the word "nanotechnology" has become very popular and is used to describe many types of research where the characteristic dimensions are less than about 1,000 nanometers.

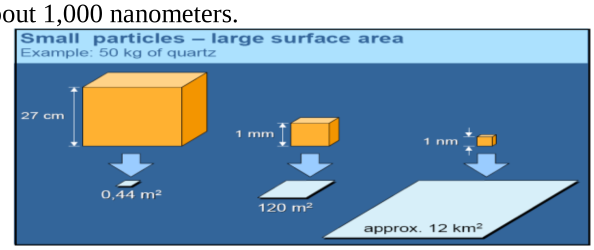

Fig 4 Different Size Dimensions of Nano Particles

Manufactured products are made from atoms. The properties of those products depend on how those atoms are arranged. If we rearrange the atoms in coal we can make diamond. If we rearrange the atoms in sand (and add a few other trace elements) we can make computer chips. If we rearrange the atoms in dirt, water and air we can make potatoes. **Example**, metal sheeting can be cut into smaller and smaller pieces in order to produce a final tool, while fabric can be cut into a variety of small shapes to be sewn together to produce clothing. In contrast, the wool of sheep and the garment-like wings of cicadas are created by atoms and molecules being added one at a time, and can be considered examples of natural nanotechnology, being bottom up. Today manufacturing methods are very crude at the molecular level.

EVOLUTION

In the world of Nanotechnology, several phases have identified that are emerging in the market place. Each phase leads to the next and of course, time is relative based on setbacks and advancements made in the Nanotech world. The timeline is of particular interest because it helps us to visualize the evolution of Nanotechnology and its impact on the business world. One thing is for sure: progress is being made and it's not reversible.

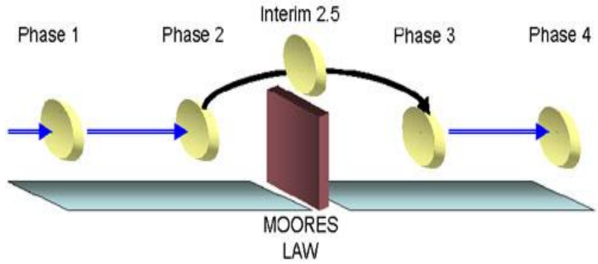

Fig 5 Evolution of Nanotechnology

Nanotech Timeline

This diagram depicts how the paradigm will shift over time. Phase 1 represents where we are today, Phase 2 could be 1 to 2 years out, Phase 2.5 is an interim phase between 2 to 4 years, Phase 3 could be 3 to 6 years, and Phase 4 is the 5 to 8 year mark.

Phase 1 - Today

Today we are at a crossroads with Nanotechnology and our ability to produce and apply its abilities to our common daily tasks. The following list summarizes where we are with Nanotech today.

- Macro atomic devices (15-35 microns across) – an ANT is 8,000,000 microns across;
- Experimental chemical elements;
- High-cost fabrication (average: $0.15 cents per RFID);
- Difficulty in mass-production of quality elements;
- No control over repair, detection, shut-off or removal;
- Ideas, thoughts on the application of Nanotech to information, storage, retrieval
- Lab experiments with "growing" nano-clusters, self-assembly of crystalline structures.

Today's devices are quite small. Tomorrow's devices will be even smaller. As indicated above, an ant is 8 million microns across; an RFID (radio frequency identifier tag) is 15 to 35 microns across. We can fit 228,571 RFID tags on the back of an ant (at 35 microns). There's a new tracking mechanism in use today called: RTLS (real-time locator systems). RTLS are much larger tags which can be re-programmed and re-charged. They are currently in use on shipping crates by the auto industry.

Today it is extremely difficult to get mass production of these elements. The current machinery (cooling mechanisms, light sources, etc.) are hidden away in the backrooms of science labs. With the amount of investment pouring into the Nanotech world, there will soon be machines that have the capacity to mass produce these elements. The dynamics will be changing automatically.

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Phases 2-4 - Future Nanotechnology Timeline

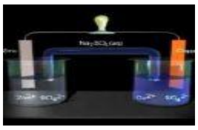
Below is a proposed timeline for Nanotechnology in the future.

Nanotechnology Timeline
Phase 2: 1-2 years
Better manufacturing/mass production Use of photo-electronic devices Visualization control Write-back capability Wave Generation Capabilities Self-Error Detection Micro / Atomic "Debuggers" Form / Function / Payload integration. Integrated re-programmable data stores, simplistic functionality Nanoviruses, attacks on nanotech components are introduced.
Interim Phase 2.5: 2-4 years
Mass production of light emitting devices (wave generation). Cheap Optical Components Expensive Atomic Fabrics Electrical and Wave Stimulation – altering structure on demand. Increase in Medical and Biological delivery mechanisms. Break-through to go beyond Moore's Law of reduction (using Quantum Physics)
Phase 3: 3-6 years
Visual Assembly – "CAD" for atomic devices End-User Visible Control for Structures Cheaper photo-resistant electronics Cheaper Optical Devices Smart Atoms / fabrics – capable of end-user interfacing. Auto-on/off transmission. Atomic tagging (identifying every atom uniquely). Terabyte computing in massive parallelism (true parallelism) through electronic signaling – invisible wave generation around the world. ON THE HEAD OF A PIN. Rise of crude, "self-aware" Nano-Tech. It knows the payload it contains; it knows what it can bind to, and what it must repel. It knows what signals it can interface with, and it knows its boundaries and configurations. Lab experiments with self-configuring "*nano- clusters*"
Phase 4: End Game, 5-8 years
True Self Assembly Smart Nano-Clusters Self-Interfacing Nano-Clusters (nanons) Self-Reconfiguring Nanons Smart Fabrics/Materials Inward Journeys into the mind through Nano-Tech

APPLICATIONS

- **Agriculture/food**
  - ➢ Agricultural chemicals/ Food

- **Electrochemistry**
  - ➢ batteries/ fuel cells/ solar



- **Electronics**
  - ➢ memory/ sensors/ semiconductor devices

- **Energy/ environment**
  - ➢ hydrocarbon processing/ oil/ special chemicals

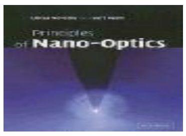
- **Life science**
  - ➢ cell biology/ genomics/ pharmaceutical

- **Textiles and Apparels**
  - ➢ fiber/ fabric/ garment finishing

- **Mechanical devices**
  - ➢ machineries /lubrication

- **Material science**
  - ➢ fluids/ particles/ polymers

- **Nano optics**
  - ➢ displays/ lithography/ optics/nano positioning/photonics



- **Homeland security**
  - ➢ forensics

MECHANICAL APPLICATION

Solid lubricants are used when conditions do not allow the usage of standard lubrication oil. This is typically under the vaccum or in oxidizing atmosphere. H-BN, graphite and WS2 are already intensively used as a solid lubricant in Industry. H-BN is especially interesting for the having both a very low friction coefficient and a high range of suitable temperature in air (up to 900^{o}C). Nano-onion powder are exceptional solid lubricants because act like nano metric ball bearing.

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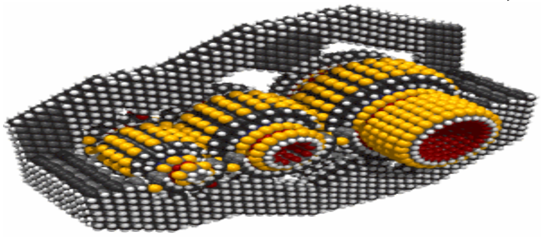


With 15,342 atoms, this parallel-shaft speed reducer gear is one of the largest nano mechanical devices ever modeled in atomic detail.

CHEMICAL APPLICATION

Nano- Shielding Nano tubes and onions of carbon have the ability to shell many materials inside their structure. It has been confirmed for many simple elements (Y, B, Bi, Gd, Ti, Cr, Fe, Zn, Mo, Pd, Sn, Ta, W) and for the some compound. This may be of some interest, to protect the nano material from their environment especially from oxidation. Magnetic particle from the data storage could be protected from the air. It also offers a possibility to synthesis diverse hybrid nano project like metallic nano roads inside the tube cavity. Nanotechnology is a manufacturing technology in the 102 nm to 0.1nm range and an electro-mechanical system technology is used in nanotechnology to produce more refined components and parts to integrate microelectronic circuit and controller systems. In essence, nanotechnology has the ability to bring order to chaos. Under a microscope, even the smoothest crystalline coatings—such as polished chrome show irregular gaps between the crystals. Over time, this causes these materials to weaken, crack and creep, especially when the structure is under stress.

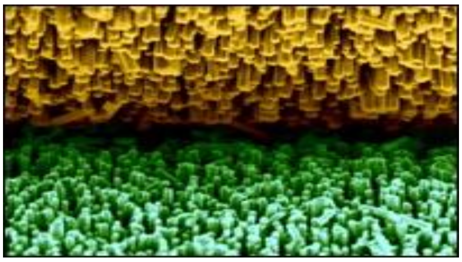
In general, experts say these gaps can be controlled in one of two ways:

- By reordering the gaps into a uniform pattern,
- By reducing crystal size.

Electro-mechanical system technology is used in nanotechnology to produce more refined components and parts.

"Scientists are figuring out how to organize polymer chain molecules—the basic stuff of textile fibre—for higher strength, higher melting points, and chemical and antibacterial impermeability", for Application as firefighter suit.

Toray Industries, Inc., has developed a type of fabric with effective moisture absorption properties achieved though a structure containing bundles of nylon threads measuring several tens of nanometers. The dyeing and printing industries in Japan are also advancing research into raising the level of technology for high-grade hands, dimension stabilizing, ultraviolet absorption, and improved flame resistance and anti-static properties, as well as for anti-bacterial, moisture-absorbing and deodorizing treatments and water-absorbing treatments for synthetic fibres. Nanotechnology include a water-repellent finishing agent, a durable hydrophilic finishing agent, for producing a synthetic film of cellulose on synthetic fibres and a strong dimension stabilizing agent for cotton. Many Japanese manufacturers of



synthetic fibres are currently developing polyester and nylon that makes use of nanotechnology. Kanebo Spinning Corp. has developed a fibre with high water-absorption properties through nanotechnology that involves producing 20 layers for maintaining water and oil content, the total thickness of which measures only around 50 nanometers. Polyester treated in this way has 30 times the ability to absorb moisture of untreated polyester and is ideal for use in the manufacturer of undergarments. Teijin Fibres Ltd. has been the first in the world to trial the production of luminescent polyester. The polyester core is covered with approximately 60 layers of nylon and polyester that have different refractive indices for light, with provisions made for red, green, blue and violet. In the case of violet, the thickness of one layer measures only 69 nanometers. This creates a mystical hue that changes according to both how light strike the fabric and the angle from which the fabric is viewed. Only reflecting light of a specific wavelength, this structure effectively brings out color.

ELECTRONIC APPLICATIONS

Electron sources are essential for screens or electron microscope. Carbon Nano tube can emit a high electron field emission current from their tip, When submitted to the bias voltage. The threshold voltage is exceptionally low because of the tip curvature. Emission surface were realized by different post-synthesis methods. A prototype display a lightening element was already produced. Hence this application may seem the closest to commercialization of present.

APPLICATION OF NANOTECHNOLOGY IN MACHINERIES

1) SURFACE COATING

Arc bond sputtering and super lattice technology are recent developments in the field of surface coating technology. These techniques combine multiple nano-scale layers of specific metals known to have excellent hardness properties and chemical resistances, into consecutive films that give the coated material a new and improved periodical structure. The application of these new coatings on industrial products is designed to change their physical properties, thus improving an individual product's toughness, resistance, performance and durability.

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II. NANOTECHNOLOGY IN INDUSTRY

Clearly, there are enormous advantages to having materials that are 100 times stronger than we have now. Objects made from these materials could be up to 100 times lighter, using 100 times less material. As a result, ultra light cars, trucks, trains, and planes would use far less energy, especially with atomically smooth surfaces to reduce internal friction and air resistance losses. Rapid advances both in terms of materials and devices are taking place globally. Almost 300 novel materials and 50 devices with unique characteristics have been successfully developed around the world. Further, this technology will have a large domestic market potential and hence would be very robust and immune to the changes that would take place beyond our borders. The next ten years will see nanotechnology playing the most dominant role in the global business environment. It is expected to go beyond the billion US dollar estimates and cross the figure of $ 1 trillion. Globally, it is seen that a large number of universities, academic institutions and companies have already starting making concrete efforts. At the molecular level, and given the capabilities of molecular nanotechnology, an obvious approach to improving the strength and toughness of a fabric would be to reinforce the fiber with carbyne molecules. Carbyne is a linear chain of carbon atoms with alternating single and triple bonds. A carbyne molecule could be cross-linked to other carbyne molecules using the same sorts of structures that Drexler designed for gate knobs in the mechanical nanocomputer. The strength and stiffness of the resulting array could be adjusted by varying the number, length, and geometry of the cross-links. Carbyne fibers made of non-cross-linked molecular arrays would have an extraordinary degree of toughness since cracks would not propagate from one molecule to the next. The various classes of *nanoparticles* that serve as the building blocks of nanomaterials and devices include nanocrystalline materials such as ceramic, metal and metal oxide nanoparticles; fullerenes, nanotubes and related structures; nanofibers and wires, and precise organic as well as hybrid organic-inorganic nanoarchitechtures such as dendrimers and polyhedral silsesquioxanes, respectively.

NANOCRYSTALLINE MATERIALS

Included here are ceramics, metals, and metal oxide nanoparticles. These materials are assembled from nanometer-sized building blocks, mostly crystallites. The building blocks may differ in their atomic structure, crystallographic orientation, or chemical composition. In cases where the building blocks are crystallites, incoherent or coherent interfaces may be formed between them, depending on the atomic structure, the crystallographic orientation, and the chemical composition of adjacent crystallites. In other words, materials assembled of nanometer-sized building blocks are micro structurally heterogeneous, consisting of the building blocks (e.g. crystallites) and the regions between adjacent building blocks (e.g. grain boundaries). It is this inherently heterogeneous structure on a nanometer scale that is crucial for many of their properties and distinguishes them from glasses, gels, etc. that are micro structurally homogeneous Nanocrystallites of bulk inorganic solids have been shown to exhibit size dependent properties, In comparison to macro-scale powders, increased ductility has been observed in nano powders of metal alloys.

- Lower melting points
- Higher energy gaps
- Nonthermodynamic structures

CARBON NANOTUBES / FULLERENES

The names derive from the basic shape that defines fullerenes; an elongated sphere of carbon atoms formed by interconnecting six-member rings and twelve isolated five-member rings forming hexagonal and pentagonal faces. The first isolated and characterized fullerene, C_{60}, contains 20 hexagonal faces and 12 pentagonal faces just like a soccer ball and possess perfect icosahedra symmetry

CARBON NANOTUBE-BASED NANODEVICES

Carbon Nan tubes are a hot research area at the moment. The excitement has been fueled by experimental breakthroughs that have led to realistic possibilities of using them commercially. Applications could include field emission-based flat panel displays, novel semiconducting devices, chemical sensors, and ultra-sensitive electromechanical sensors.

III. NANO-INTERMEDIATES

Nanostructured films, dispersions, high surface area materials, and supramolecular assemblies are the high utility intermediates to many products with improved properties such as solar cells and batteries, sensors, catalysts, coatings, and drug delivery systems. They have been fabricated using various techniques. Nanoparticles are obvious building blocks of nanosystems but, require special techniques such as self-assembly to properly align the nanoparticles. Recent developments have lead to air resistant, room temperature systems for nanotemplates with features as small as 67 nm. More traditionally, electron-beam systems are used to fabricate devices down to 40 nm.

IV. NANOCOMPOSITES

Nanocomposites are materials with a nanoscale structure that improve the macroscopic properties of products. Typically, nanocomposites are clay, polymer or carbon, or a combination of these materials with nanoparticle building blocks. Nanocomposites, materials with nanoscale separation of phases can generally be divided into two types

1. Multilayer structures

Multilayer structures are typically formed by gas phase deposition or from the self-assembly of monolayers.

2. Inorganic/organic composites.

Inorganic/organic composites can be formed by sol-gel techniques, bridging between clusters or by coating nanoparticles, in polymer layers

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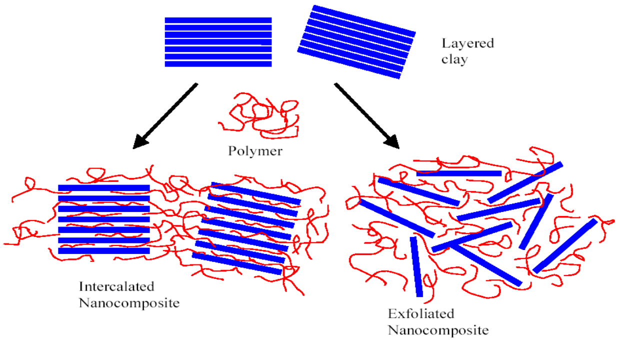


Fig 6 Polymer-Clay Nano Composites

The large industrial demand for polymers has lead to an equally large interest in polymer composites to enhance their properties. Clay-polymer nanocomposites are among the most successful nanotechnological materials today. This is because they can simultaneously improve material properties without significant tradeoffs.

V. MODERN DEVELOPMENTS

1) Nanowires allow 'power dressing'

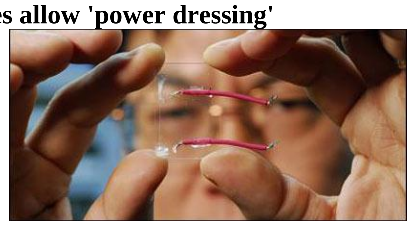
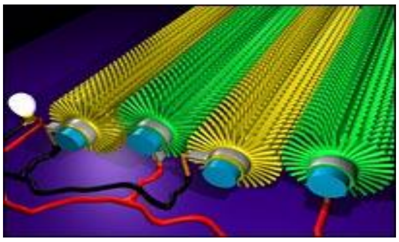


Fig 7 "Power Dressing" May Soon Have a Very Different and Literal Meaning.

Scientists in the US have developed novel brush-like fibers that generate electrical energy from movement. Weaving them into a material could allow designers to create "smart" clothes which harness body movement to power portable electronic gadgets. Writing in the journal Nature, the team says that the materials could also be used in tents or other structures to harness wind energy. "Our goal is to make self-powered nanotechnology," Professor Zhong Lin Wang of the Georgia Institute of Technology and one of the authors of the paper told BBC News "Airflows, vibrations - all these are mechanical energy that we can harvest to power devices." Dr Dianne Jones, technical director of textile electronics firm Fibretronic, said that as the market for wearable electronics expands, technologies such as the nanofibres would become increasingly attractive. "Any new power source which could provide a more integrated and soft solution in place of conventional hard battery technology would be very attractive for clothing or other electronic textile-based applications," she said. Ottilia Saxl, chief executive of the Institute of Nanotechnology, believes the technology could also find a use in healthcare. "It could perhaps be used to power tiny medical devices like a true cochlear implant or heart pacemaker, or a delivery mechanism for subcutaneous drug delivery implants or antibiotic drug reservoirs for preventing infection in retinal implants," she said.



2) Hair spray

The nano-generators, as the technology is known, consist of pairs of fibres that look similar to tiny, bendable bottle-brushes. At the core of each fibre is a Kevlar stalk. "On the surface we grow crystals called nanowires," said Professor Wang. Each tiny wire is 30-50 nanometres (billionths of a meter) in length and is made of zinc oxide. They are grown in solution. "The growth is so spectacular that on the surface of the fibre all these nanowires stick out radially," he said. "And you can grow these on any substrate - hair or whatever you have." One of the bristled fibres is also dipped in gold to act as an electrode. When the pair is scrubbed together they create a small amount of electrical energy. "The fibre has a piezoelectric effect," said Professor Wang. "This is an important effect that converts mechanical energy to electricity." Experiments with the prototypes showed that two 1cm-long fibres could generate a current of four nanoamperes and an output voltage of about four mill volts. "If we can optimize the design we can get up to 80 mill watts per square meter of fabric - that could potentially power an iPod." "The ability to generate power for personal electronics using the clothing we wear would be a breakthrough in smart and interactive garments".

VI. NANOSENSORS TO REPLACE RFID CHIPS ON CONSUMER PRODUCTS

Background Of RFID Technology: - An RFID tag is a uniquely identified (or identifiable) object that can be embedded to any physical body to track its position or location. Tags are of various kinds, covering the entire spectrum the passive tags powered in the presence of a reader, to a continuously signal-emitting active tag. Both active as well as passive RFID tags consist of a small microchip that contains a unique ID encoded within it & fall within a range of frequencies that are used according to the international ISO specifications for air interface (ISO-18000 2-7). Some of these specified frequencies are more suitable to passive operation (i.e. shorter range, larger bandwidth, lower power) while some are more suitable to active RFID technology. The rest of the tag consists of a mechanism to transmit this unique ID to an "Interrogator" or a reader that can identify this tag.

All tags use some kind of FM modulation in order to transmit the tag's unique ID to the Interrogator

- Interrogated remotely via RF/inductive signals (passive) and direct broadcast (active)
- Long life - can withstand mechanical shocks, dirt etc

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- Non-directional, with non line-of-sight functioning that enables complete automation of RFID enabled (or supported) systems and processes.
- Non-contacting (tamperproof) and non-obtrusive (transparent to user)
- Robust protocol - fault tolerant transmission, inherently engineered for error-handling and recovery
- Flexible with minimal interference
- Unique identification number allows stronger authentication of personnel and systems.

Comparison of Active vs. Passive Tags

Feature	Active Tag	Passive Tag
Frequency	420-450 Mhz, 63.57 Mhz	125Khz, 13.56Mhz, 920-930Mhz, 2.4-5.8Ghz
Typical usage	Position tracking, location-based computing, "Aware" systems that can react to specified physical signals and stimuli	Object identification, process automation, Retail
Typical environment	Hospitals and healthcare facilities, Warehouses & Freight management facilities, Defense and high-security installations	Retail sales, Warehouse and freight management, Logistics, Manufacturing & Supply chain management, Agriculture
Range	1 - 100 m	2 - 50 cm
Cost	Medium, Re-usable for long-term cost recovery	Low, but non-reusable tags

A) ACTIVE TAGS

In the case of an Active tag, an internal power source (battery) is used to power the transmission - which broadcasts the tag's unique ID to all sensors/receivers that are listening on the specified frequency. The signals are non-directional, and may be received by one or more sensors. These signals then need to be interpreted by the system to determine the location of the tag within a facility. Most active RFID badges usually work between 420 - 450 MHz. Some of the tags also work between the 63.57 MHz frequency range, which compensate for the lower range (90m) with much longer battery life, for practical consideration. They are typically used for applications like:

- Tracking very mobile objects - including personnel in a facility-like warehouse loading equipment etc.
- Tracking objects of very high value, that need "ubiquitous" security without necessarily having personnel watching over it all the time.

TECHNOLOGY

Active tags are self-powered - usually by a permanent voltage source like an in-built battery. Other power sources like solar powered tags are currently in development at netlink rfid ™, for a variety of innovative uses. The voltage source is used to periodically send out active RF signals, broadcasting the ID of the tag to all available receivers, from where it can be picked up by the (software) system to "track" the tag. Some of the newer tags have an in-built motion detector that broadcasts signals only when the tag is in motion - which helps to extend the battery life for those tags very significantly. For example, some tags can have a temperature or pressure sensor built-in, and can broadcast this information to RF sensors for "active" control. The RFID tags utilize electromagnetic energy to send signals to program the transponder by switching the electromagnetic field on and off. The duration of the on or off-phase defines whether a low-bit or high-bit of information is being transmitted. This technique of data transfer is called Pulse Width Modulation.

B) PASSIVE TAGS

In the case of a passive RFID tag, the construction consists of an antenna that serves a dual purpose - it acts as a "coil" that generates enough electric current when placed within an electromagnetic field (i.e. Close to a passive reader) to "power" the microchip. The unique ID encoded within the microchip is then transmitted in an electromagnetic pulse that uses the antenna to broadcast the pulse back to the reader. Passive tags in the HF range are commonly found in the 125 KHz and the 13.56 MHz range. Some of the newer tags are also available in the UHF range, with larger bandwidth, read speeds, as well as larger read ranges. These tags are suitable for the following purposes:

- For tracking items within a facility - without having to necessarily know exactly where they are at any point of time (which would require 'active' technology). This requirement falls within the realm of "Access Control and Management", and is usually accomplished by protecting all entry and exits in the facility with readers, which capture movement of tags in and out of the facility.
- For automated inventory management, including expiration tracking/notification, ad-hoc operations (e.g. The "Smart Shelf" concept where the system should track when items are taken off or put back on the shelf without any human intervention), and for fast and efficient (and automated) tracking of material movement and placement within a facility.

TECHNOLOGY

Passive tags operate on principle of parasitic power transfer through electromagnetic induction. The core RFID chip on a passive tag contains a unique ID, and also necessary circuits to power (and operate) this chip when any current flows through the circuit. The power is provided by the external reader to the passive RFID tag through electromagnetic induction, as the copper loop in the tag generates a current as it travels through the electromagnetic field created by the reader. Since the electromagnetic field power falls off as the

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square of the distance, hence passive RFID systems are limited in the distance of operation - often operating between only 2 to 5 centimeters. Each tag has a unique ID that is set during manufacture, and cannot be changed. When the RFID chip is triggered, it uses the copper loop as an antenna, and broadcasts it's unique ID, which is picked up by the RFID reader, thus triggering a "tag read". This tag read can then be transmitted to an Enterprise information system, and processed accordingly.

Advantages of RFID

- Greater control over inventory
- Increased security
- Greater visibility of your facility
- Better time management of mobile personnel and resources
- Reduction in time spent on maintenance and record-keeping
- Better organization of assets and resources
- Reduction in paperwork
- Delivers accurate and precise information

Some of the factors impeding RFID adoption are identified. These include:

Unit cost of tags and the overall cost of RFID implementation. This is one of the greatest obstacles to RFID adoption in the retail sector.

Availability and standardization of RFID frequencies. Although there are some frequencies in the low and medium ranges that are commonly allotted for RFID use worldwide, there is no common agreement on the ultra high frequency (UHF) band (860−930 MHz) or microwave frequencies, which are either unavailable or which vary between countries.

Privacy issues are still making news. With consumer concerns—including the perceived risk of privacy invasion and misuse of data by retailers—of critical importance.

Physical limitations. For example, radio waves are incapable of traveling easily through metals and liquids.

The identification of these issues emphasizes that RFID, in its current guise, may not be suitable for every business scenario. On the other hand, there are occasions when the technology can work wonders and help organizations exceed their expected return on investment (ROI). The most important thing is to evaluate the technology for its suitability to specific business processes and operational requirements. This demands that enterprises assess the feasibility of RFID deployments in advance and chalk out a detailed RFID implementation roadmap. During this evaluation, they should involve partners who possess a sound understanding of their business, as well as of real-world RFID implementations. In other words, RFID is no longer a technical solution to a business problem. Instead, it is a business solution that uses an emerging technology.

Beyond RFID

Nan sensors will be able to store and transfer even greater amounts of information than RFID chips. As with RFID, not only will pallets be tractable, but individual items can be tracked, followed and monitored from the production facility to the warehouse to the store and ultimately to the consumer.

Warning

Just as RFID caught the attention of privacy advocates and forced major retailers to revisit their strategy of employing these devices, nanosensors and nanotechnology, in general, is increasingly becoming a topic of concern. A number of organizations, especially environmental groups, are expressing concerns about nanotechnology’s impact on both the environment and human health.

Regulating Nanotechnology

Most of the groups are calling for significant regulatory oversight; however a few are taking a more strident position and seek an outright ban on nanotechnology. And just as the regulatory and public relations battles that erupted over genetically modified organisms (GMOs) and BGH (bovine growth hormone) have shown that the alteration of food products strikes a very sensitive cord in a sizeable portion of the population, industries or businesses that are considering employing nanotechnology can expect to confront similar issues. The U.S. government is aware of these concerns and is making a significant investment in these issues. The new National Nanotechnology Initiative has identified this area as a priority and has established the Centre for Biological and Environmental Nanotechnology Research at Rice University in Houston to proactively explore these issues and identify options for how government and industry might want to regulate nanotechnology. If nanotechnology is proven to be safe, and experts are optimistic that it will, there is a real possibility that in the near future nanotechnology will not just be a topic to read about on the back of cereal boxes, it will be in the packaging and even the product itself.

RISKS TO ADOPTION OF RFID

• **The high cost per tag:** The cost of RFID tags is 25 to 30 cents (USD) per tag, down from 40 cents (USD) in 2002. It typically makes sense to place tags only at the packages product level (pallet or carton), or on the highest-margin products, where the tags represent much less than 1 per cent of the total cost of the product. With demand increasing and production costs declining, the tags are expected to reach 5 cents per tag in 2006.

• **Mountains of data, who is going to mine it?** The location of pallets, cases, cartons, totes and individual products in the supply chain, the activities of picking and shipping, the tracking of expiration dates, and recalls will all produce mountains of real time data. RFID applications will generate a lot of "thin" data – data pertaining to time and location – which should also prove valuable for determining product seasonality and other trends.

• **Limited edge computing power:** Most retail outlets are not tuned to handle the data and information workload required to make RFID effective at the product level. Reaping the rewards will require a large investment in computing power, bandwidth, storage, IT operations and administration per store.

• **Product-level tagging does not always work:** Current tags do not transmit well on certain products, such as liquids or metals. This limits the overall benefit of RFID until the problem can be resolved.

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• **Complexity and required investment levels:** RFID implementation is complex in all ways: process re-engineering, integration, maintenance, data storage, and design and deployment. A full implementation on an accelerated cycle could require a full year's IT budget and resources. As a result, most companies have only rolled out limited pilots and are cautious to commit to boarder deployments.

• **No one standard for technology:** Above all, as yet there is no one standard for the technology and nowhere is the lack of a global standard more vexing than with the most basic elements of RFID. Not all tags and readers can communicate with each other. So a retailer might need to have two or more types of readers in its warehouses to read different tags from different hardware vendors. Therefore, there's no universal interoperability among hardware equipment.

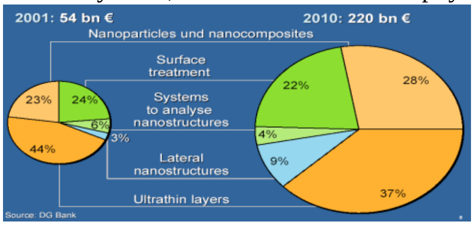
• **Acts abnormally when it's near certain elements:** Liquids, metals, porous objects might not just be suited for RFID. Unilever has had similar problems with its products containing liquids and moisture. Hewlett-Packard has reported problems with its ink-jet cartridges, which contain ink and metal, and are wrapped in metalized paper.

RFID: PRIVACY AND SECURITY ISSUES

As more customized technologies evolve, the issues of privacy and security will take centre stage. In order to ensure privacy, customers would have to opt into a programme where special offers are presented to them in-store via a Bluetooth-enabled device which gives retailers the ability to add a Java applet to a phone or a PDA that can only be read by the store the customer is in, so the customer is not constantly bombarded with outside offers. Security issues will also become an increasing concern as more stores add high-speed Internet connections. The IBM Privacy Research Institute is working with retailers and other businesses to develop technologies and guidelines to protect consumer privacy, while enabling retailers to obtain the necessary data. Hopping at IBM predicts that privacy concerns will be a non-issue if retailers pay attention to how to protect their customers. “We're tracking something like 1,500 retail hacker incidences a month now,” he reveals. “Last year, there were 76,000 hacker attacks on companies in just six months." With hacking and viruses on the rise, retailers need to take precautions to ensure that their systems and data are secure. Whatever the risks involved, companies are already exploring more advanced uses for RFID: Tyre manufacturers have embedded RFID chips in tyres to determine – with greater accuracy – time to failure; Pharmaceutical companies have embedded RFID chips in drug containers to better track and avert the theft of highly controlled drugs; and so on. Going a step further, very recently New York based Media mark Research has announced plans to test RFID tags to be printed on the pages of magazines so that it allows detailed measurements on how much time magazine readers spend reading articles and looking at advertising.

VII. GROWTH OF NANOTECHNOLOGY

I want to build a billion tiny factories, models of each other, which are manufacturing simultaneously. . . The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom. It is not an attempt to violate any laws; it is something, in principle, that can be done; but in practice, it has not been done because we are too big. — Richard Feynman, Nobel Prize winner in physics



This technology will have a large domestic market potential and hence would be very robust and immune to the changes that would take place beyond our borders. The next ten years will see nanotechnology playing the most dominant role in the global business environment. It is expected to go beyond the billion US dollar estimates and cross the figure of $ 1 trillion

VIII. FUTURE PROSPECTS

RFID Tracking and Nanotechnology for BI Imagine, a smart RFID (radio frequency identifier tag) - in other words, not just one that bounces a signal that was received by a transmitter, but one that emanates a unique number (like a RIN (RFID identification number) - like a VIN only for RFID's. We realize that already we have RTLS (real-time locator systems) with this technology embedded, but imagine it at a smaller scale. RTLS are currently very large (compared to RFID tags). How would this affect BI? What if it could use Nanotechnology and an embedded power source (like Nanotech reports is possible) to power a unique signal? What would happen to the supply chain for example? It is possible to send a satellite signal to each MRFID (modified RFID). This would have to be done using Nanotech, for an internal power source, and a transmitter would have to be embedded, or an encoding device. In other words, since the power source is usually too weak to respond to a satellite signal, it would have to record where it was (latitude and longitude). Every hour it would record it's lat/long in a DNA computing style by folding DNA elements. This technology will come to pass, like it or not - it will happen within 15 to 20 years (or sooner) because vendors would have a huge increase in revenue as a result.

* Nanotech is already here, and there are limitless utilizations for it.
* Privacy and Ethics are a hot debate in the nanotech industry
* There are some interesting applications for MRFID in the productized world.

1) FUTURE CHALLENGES INCLUDE:

** Reproducible mass production at kilogram levels of identical high quality CNT.
** Development of self-sustaining, self-replicating hybrids of CNT and silicon to perform augmentation and repair of DNA.

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** Development of intelligent wearable systems using nano technology. Solution to cancer, Parkinson 's disease and AIDS through biosensors, devices and drug delivery systems.
** Realization of molecular sized machines. Remote sensing through nano Unmanned Aerial Vehicles and satellites
The nano is the greatest building block for healthcare, structural material, in electronics, automation, etc, and will become the platform for new cutting edge technologies to grow for the better living of mankind.

IX. CONCLUSION

There are many important incentives which make it seem likely that the pace of development will continue to grow. Accordingly, the technology is expected to mature within 15 years and this will impact the manufacturing industry by bringing new tools for the manufacture of machines / fabrics, order of magnitude improvements in mechanical / material properties and performance, but a decentralization of manufacturing. If you've read the Michael Crichton best-selling book, "Prey," in which a research lab creates self-replicating microscopic robots that turn against its creators, you probably view nanotechnology as a mysterious predator waiting to wreak havoc on an unsuspecting society. In the real world, scientists are developing applications based on micro molecules that do indeed have the potential to change the way we live-but for the better.
"Nanotechnology is an enabling technology that makes existing applications work better or more efficiently"

"Girish Solanki"

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